Optimization of the irrigation time and irrigation frequency by using Hydrus-2D and a capacitance FDR sensor.

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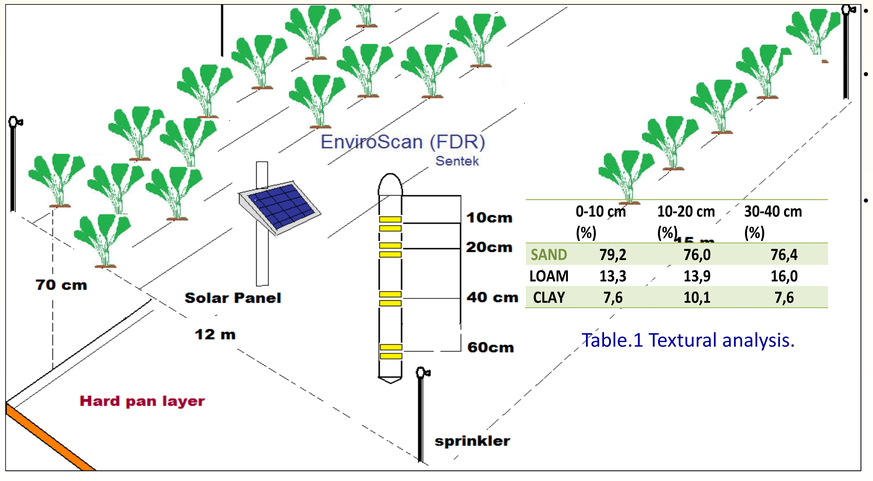
1.Introduction

- The Spanish research center for the sugar beet development (AIMCRA) has a network of experimental sites for its improvement of the crop.
- AIMCRA provides to his members with a SMS service regarding weekly sugar beet water requirement. Nevertheless, it is the farmer´s decision to decide how to irrigate.
- AIMCRA´s recommendations relates to crop water requirements, management of irrigation systems and improvement of irrigation unit design (Morillo-Velarde 2001, AIMCRA 2009).
- Uniformity of water application on irrigation systems has an effect on sugar beet yield (Ortiz et al. 2010).

2. Materials and Methods

- The experimental site is located at Villavieja (Valladolid) with sandy-loam soils and a hard pan layer at 70 cm depth. Soil samples were taken at 5, 25 y 40 cm for texture determination
- FDR was installed at the lowest point of the farm (see Figure.1). Water content readings (m^3/m^3) at 10, 20, 40 and 60 cm depth were recorded every 30 minutes.
- The land is irrigated by solid sprinkler set units spaced 12 m X15 m.
- An irrigation Simulation of the soil profile explored by the probe was compared with the readings from the sensor



	0-10 cm (%)	10-20 cm (%)	30-40 cm (%)
SAND	79,2	76,0	76,4
LOAM	13,3	13,9	16,0
CLAY	7,6	10,1	7,6

Table.1 Textural analysis.

Figure.1 Diagram of the Sensor set up and results from the textural analysis at three depths: 0-10cm, 10-20cm and 30-40cm.

3. Hydrus 2D simulation.

- Boundaries: 70 cm deep X 10 cm wide soil profile.
- One-dimensional Flow: Laterals (zero-flux), surface (0.51 cm/h) and bottom (10^{-10} cm/h). A mesh was automatically generated to discretise the flow domain into triangles (see Fig. 1).
- Hydraulic Parameters: From van Genuchten-Mualem model (van Genuchten, 1980) and textural analysis at the first 40 cm of soil (see Table.1): Saturated water content q_s= 0.38 (m^3/m^3), residual water content q_r= 0.0443 (m^3/m^3), K_s= 2.77 cm/h, a= 0,037 cm^{-1}, n= 1.5419 and l= 0.5.

4.Results

- Although simulations predict the general trend of water movement, water at saturation predicted by Rosetta was less than the maximum water content from the probe.
- Results show that trends for P-40 and P-60 were similar: water content does not change in the deepest zone and its change in the other is negligible.
- In profiles P-10 and P-20, major differences were shown: Simulations do not depict the fast movement of water as it is shown with probe readings. This could be due to the poor characterization of soil properties that will not fit very well the real conditions.
- The Wilting point calculated for a sandy-loamy-soil ≈ 10% (Gardner, 1965)
- According to Doorenbos and Kassam (1979), it is recommended to irrigate at 50-60% of the available water holding capacity
- Water content for the profile 10-20 cm, before irrigations, was above permanent wilting point but bellow the optimum range for maximizing crop yield response (50-60% depletion of readily available water RAW, (Θ irrigation = 20%)

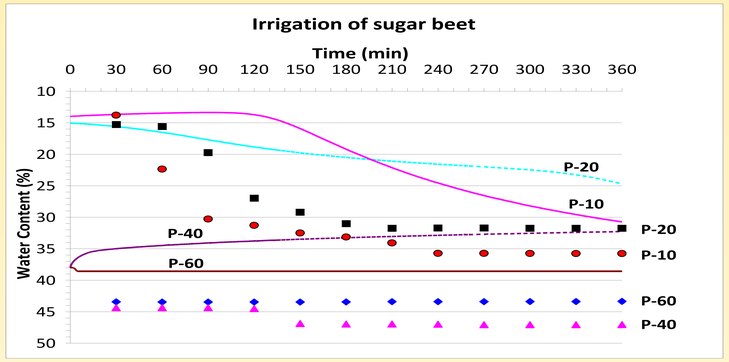


Figure.2 Diagram of the Sensor set up and results from the textural analysis at three depths: 0-10cm, 10-20cm and 30-40cm.

5. Conclusion

- Simulation of evolution of water content within the soil with Hydrus 2D predicts the general trend of water movement fairly in the deepest profiles although differences in the shallow profiles could be explained for a poor characterization of soil properties.
- Farmer's applies irrigation during 6 h every week. Considering that consecutive irrigations should be done at 50-60 % of RAW, results show that irrigation time could be reduced to 4 h,since water content remained fairly constant after that time; and irrigation interval could also be reduced in 1-2 days.

References

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Acknowledgments

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